**Overview of Diabetic Retinopathy (DR)**

Diabetic Retinopathy is a common complication of diabetes mellitus that damages blood vessels in the retina, potentially leading to vision impairment or blindness if not detected and managed early. It progresses through stages: non-proliferative DR (NPDR, early microvascular changes) to proliferative DR (PDR, advanced with new vessel growth and risks like hemorrhage). The core problems include delayed diagnosis due to lack of symptoms in early stages, limited access to specialized screening (e.g., in primary care or resource-poor settings), reliance on invasive or expert-dependent methods, treatment resistance (e.g., to anti-VEGF therapies), and multifactorial pathogenesis involving inflammation, metabolism, and vascular issues. While not fully solved—DR remains a leading cause of blindness in working-age adults globally—recent advances in AI/ML models, biomarkers, and imaging have improved early detection, risk prediction, and personalized management, reducing progression risks through timely interventions. Research from the Frontiers topic (and related volumes) highlights these progresses, often using real-world clinical data for model training.

**Key Models, Training Data, Accuracies, and Contributions**

Based on articles from the "Advances in the Research of Diabetic Retinopathy" collection (topic ID 29401) and closely related works, several studies employ machine learning and diagnostic models for DR screening, risk prediction, and progression monitoring. These models are trained on patient cohorts, clinical metrics ,and sometimes metabolomics or imaging data. Below is a table summarizing prominent examples, including model names, training data details, accuracy metrics, problems addressed, and solution status. Not all 20 articles in the topic focus on models—many explore biomarkers, treatments, or associations—but those that do emphasize AI/ML for efficiency.

| **Article Title / Focus** | **Model Name(s)** | **Training Data** | **Accuracy Metrics** | **Problem Addressed** | **Solved or Ongoing?** |
| --- | --- | --- | --- | --- | --- |
| A Diagnostic Model for Screening Diabetic Retinopathy Using the Hand-Held Electroretinogram Device RETeval | Decision Tree (primary; built with Rpart in R); Random Forest (for feature ranking) | 232 eyes from type 2 diabetes patients (127 no DR, 105 DR) + 70 healthy controls; split 70/30 train/test; features: DR score from RETeval (ERG parameters like implicit time, amplitude), clinical variables (e.g., DM duration, HbA1c, visual acuity); collected 2019-2020 in China. | Decision Tree (combined factors): Sensitivity 93.3%, Specificity 80.3%; AUC 0.881-0.972 for DR/VTDR detection. DR Score alone: Sensitivity 74.3%-95.7%, Specificity 90.6%-93.5%. | Early screening in resource-limited settings without pupil dilation or experts; high misdiagnosis in early DR. | Ongoing advance: Improves sensitivity over device alone, suitable for community use, but needs larger datasets and optimization to reduce false positives. Not a full solution due to ethnic variations and sample limitations. |
| Using Machine Learning Techniques to Develop Risk Prediction Models for the Risk of Incident Diabetic Retinopathy Among Patients With Type 2 Diabetes Mellitus | XGBoost (top performer); Random Forest, Logistic Regression, Support Vector Machine, K-Nearest Neighbor | Retrospective cohort of 7,943 type 2 diabetes inpatients (no baseline DR; 1,692 developed DR); split train (5,559)/test (2,384); features: 18 clinical/demographic (e.g., HbA1c, diabetes duration, blood lipids, eGFR); data from 2010-2018 in China; 5-fold cross-validation. | XGBoost: AUC 0.913, Accuracy 79.9%, Sensitivity 90.2%, Specificity 77.1%; PPV 51.6%, NPV 96.7%. Performs well up to 10 years ahead (AUC 0.834-0.966). | Predicting future DR onset in type 2 diabetes for risk stratification; limitations of cross-sectional models. | Ongoing advance: Enables early prediction (avg. 2.9 years before diagnosis) using routine data; high generalizability potential but requires multi-center validation. Not solved, as it's retrospective and single-center. |
| Plasma Metabolomics Reveals Metabolic Profiling For Diabetic Retinopathy and Disease Progression | LASSO-Logistic Regression (for biomarker selection and risk scoring); OPLS-DA, PCA (for profiling) | Plasma from 78 type 2 diabetes patients (32 no DR, 21 NPDR, 21 PDR); metabolomics via UHPLC-QE-MS (>50,000 features); clinical features (e.g., HbA1c, FPG); collected 2019-2021 in China. | DR Risk Score (pseudouridine-based): AUC 0.80, Sensitivity 97.6%, Specificity 53.1%. PDR Risk Score (4 metabolites): AUC 0.82, Sensitivity 76.2%, Specificity 77.4%. | Identifying biomarkers for DR occurrence and NPDR-to-PDR progression; challenges in non-invasive monitoring. | Ongoing advance: Non-invasive plasma-based scores for early detection/progression; correlates with HbA1c. Not solved—small sample, needs quantification and larger cohorts for clinical use. |